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(54) **NEGATIVE PRESSURE CONNECTOR SEAL**

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CPC ***F16L 21/005*** (2013.01); *A61F 7/0085* (2013.01); *F16K 15/1471* (2021.08)

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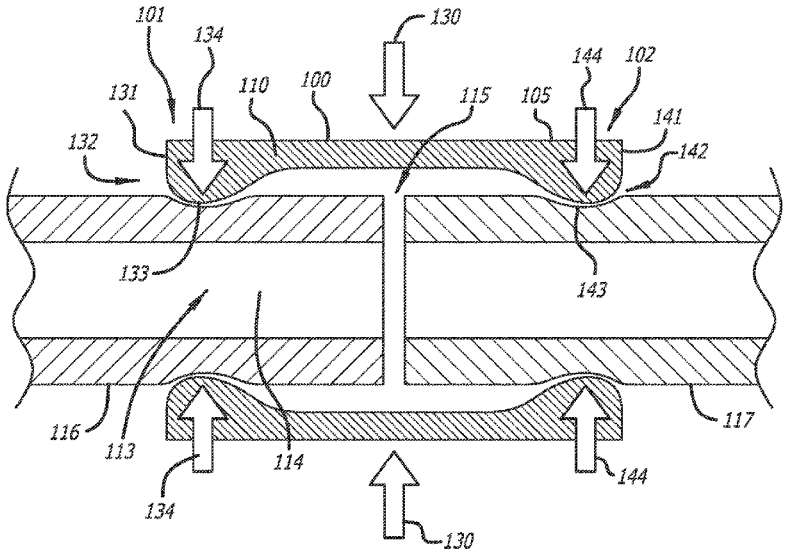
(57) **ABSTRACT**

A sealing member for providing a seal between fluid connectors includes a tubular member defining a lumen extending between a first end and a second end. The tubular member may receive a first connector via the first end and a second connector via the second end, and includes an annular wall extending between a first annular portion adjacent the first end and a second annular portion adjacent the second end. The first annular portion may engage the first connector, and the second annular portion may engage the second connector. When a pressure within the lumen is negative, atmospheric acting inward on the annular wall compresses the sealing member to define a contact force between the second annular portion and the second connector sufficient to define a fluid seal between the sealing member and the second connector.

24 Claims, 3 Drawing Sheets



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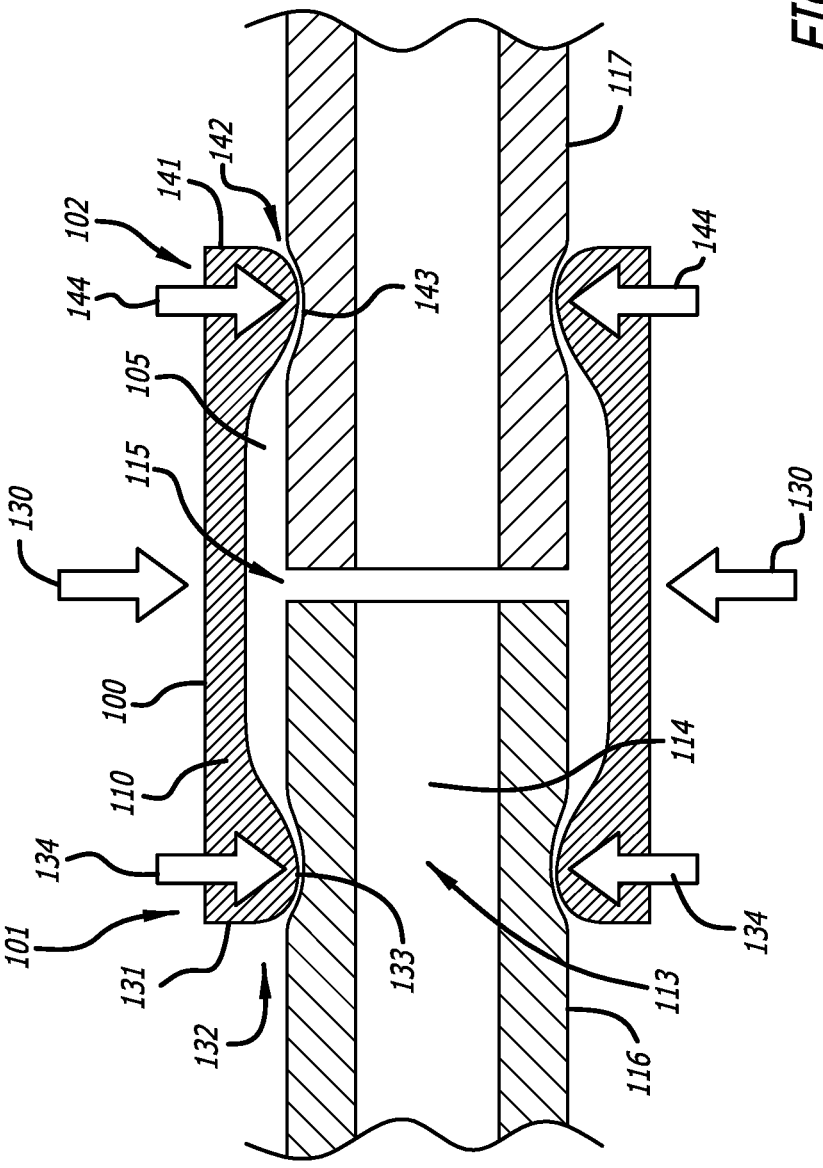
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142
141
102
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113
132
116

FIG. 1

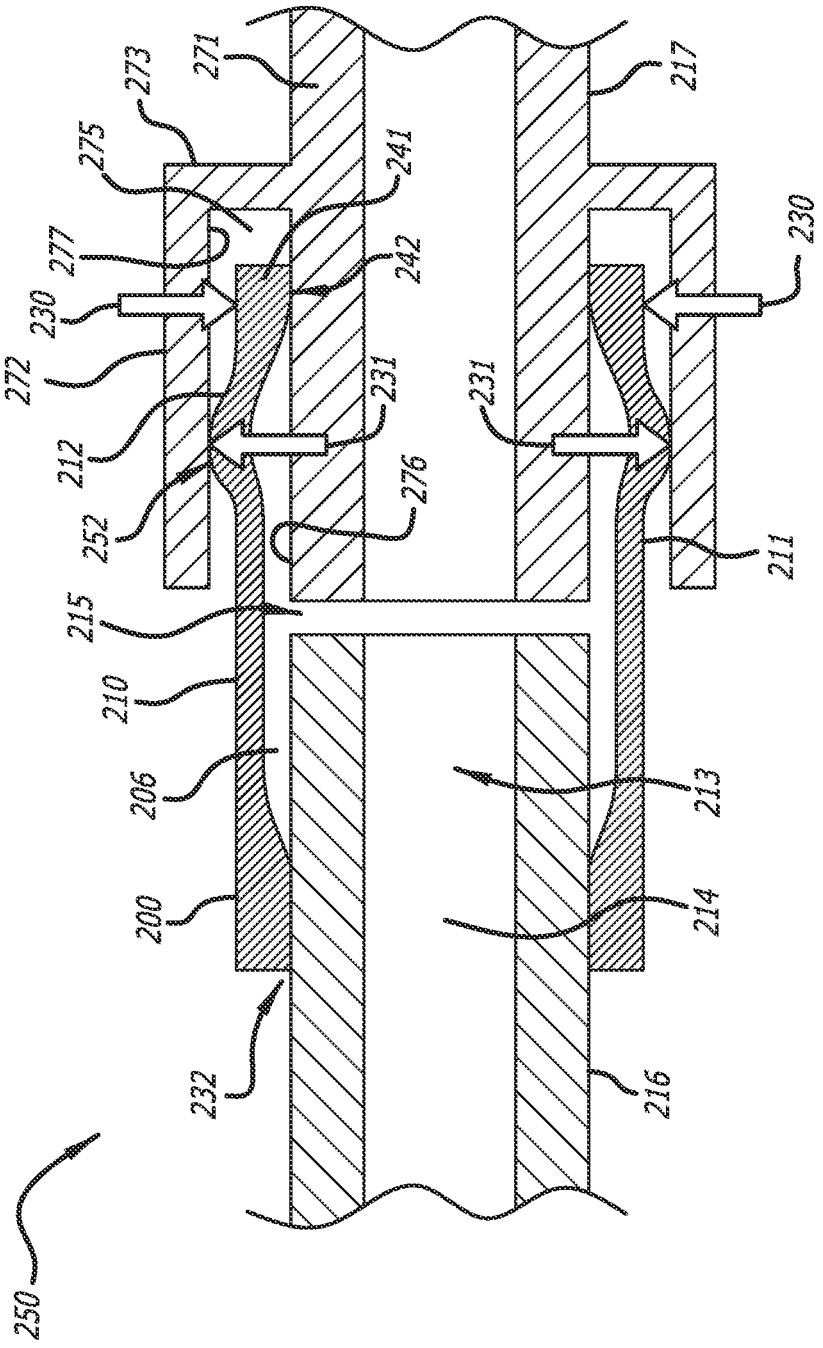
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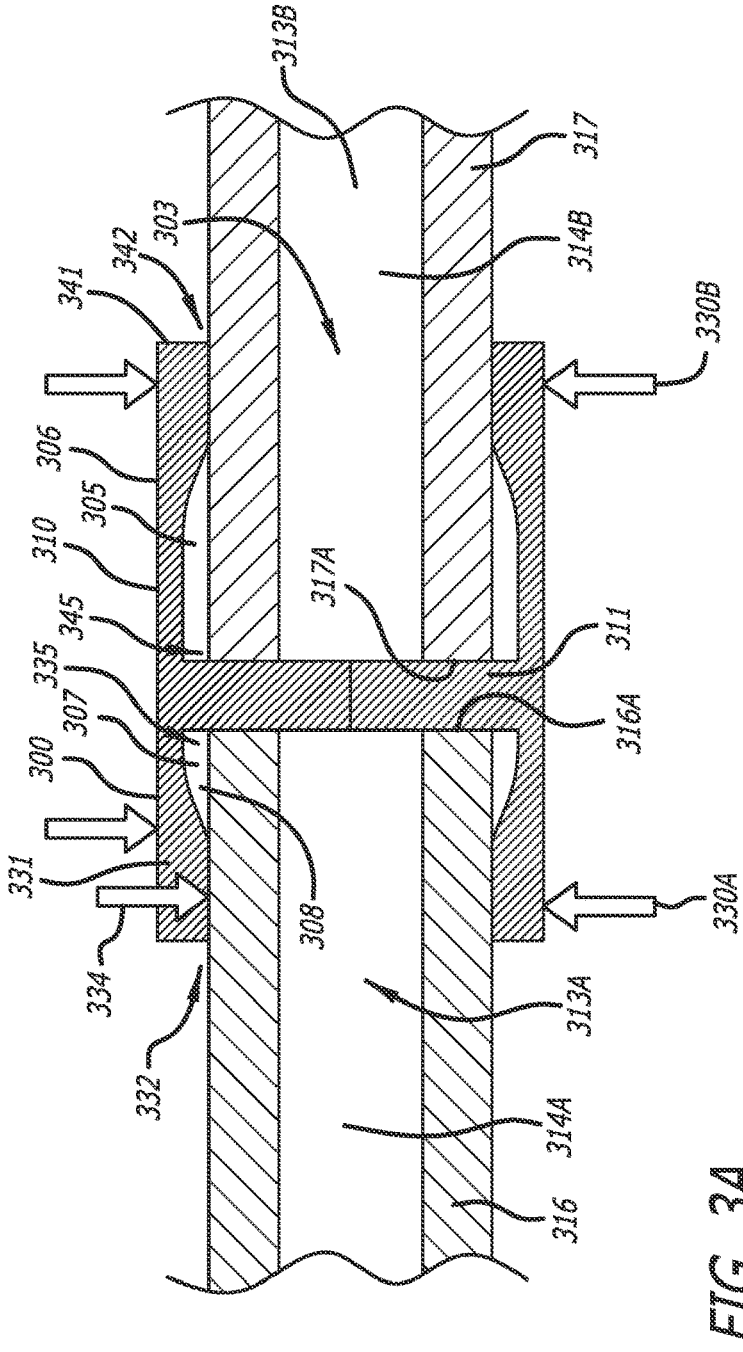
FIG. 2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330B
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316A
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330A
334
313A
332
314A
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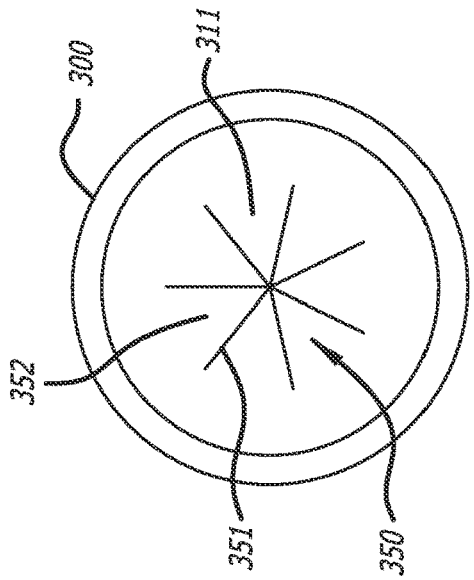
FIG. 3A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351
350

FIG. 3B

NEGATIVE PRESSURE CONNECTOR SEAL

PRIORITY

This application claims the benefit of priority to U.S. Provisional Application No. 63/219,247, filed Jul. 7, 2021, which is incorporated by reference in its entirety into this application.

BACKGROUND

Targeted temperature management (TTM) systems circulate a fluid (e.g., water) between one or more thermal contact pads coupled to a patient and a TTM fluid control module via a fluid deliver line (FDL). Fluid connectors between the FDL and the pads and between the FDL and the control module provide for the selective connecting and disconnecting of the components. As a clinician may connect and disconnect the components for each TTM procedure (potentially several times per day), it is desirable for the connection to be simple, straight forward, and require minimal forces. It is also important for the fluid seal between the connectors to be reliable.

To prevent water leakage from the TTM system, the system may be configured to operate under a negative pressure so that, in the case of a leaking connection, air may leak into the system as opposed as to water leaking from the system. Disclosed herein are embodiments of devices and methods for utilizing negative internal pressure to improve connector seal reliability while minimizing clinician applied forces to make the connection.

SUMMARY OF THE INVENTION

Briefly summarized, disclosed herein is a sealing member for providing a seal between fluid connectors. The sealing member includes a tubular member defining a lumen extending between a first end and a second end. The tubular member is configured to receive a first connector via the first end and a second connector via the second end. The tubular member includes an annular wall extending between a first annular portion adjacent the first end and a second annular portion adjacent the second end. The first annular portion is configured to engage the first connector and the second annular portion is configured to engage the second connector. When a pressure within the lumen is negative, atmospheric acting inward on the annular wall compresses the sealing member to define a contact force between the second annular portion and the second connector sufficient to define a fluid seal between the sealing member and the second connector.

The pressure within the lumen is defined in response to a fluid pressure within a lumen extending through the first and second connectors and the lumen may be in fluid communication with the lumen extending through the first and second connectors.

In some embodiments, when the pressure within the lumen is negative, atmospheric acting on the annular wall compresses the sealing member to define a contact force between the first annular portion and the first connector sufficient to define a fluid seal between the sealing member and the first connector.

In some embodiments, the first annular portion is attached to the first connector and may also be sealably attached to the first connector. The second annular portion is configured to slidably engage the second connector when a non-negative pressure is defined within the lumen.

One of the first connector or the second connector may be attached to one of a fluid delivery line or a thermal contact pad of a targeted temperature management system, and the other one of the first connector or the second connector may be attached to the other one of the fluid delivery line or a thermal contact pad. The fluid pressure may be defined in accordance with operation of the targeted temperature management system.

The sealing member may further include a septum extending across the lumen between the first connector and the second connector, and the septum includes a pressure actuated valve. The valve is configured to (i) prevent fluid flow through the septum when a fluid pressure across the septum is below a defined pressure limit, and (ii) allow fluid flow through the septum when the fluid pressure across the septum exceeds the defined pressure limit.

Also disclosed herein is a fluid connector system, including a first connector, a complementary second connector fluidly coupled with the first connector, and a tubular sealing member defining a lumen extending between a first end and a second end. The tubular member is configured to receive the first connector via the first end and the second connector via the second end. The tubular member includes an annular wall extending between a first annular portion adjacent the first end and a second annular portion adjacent the second end. The first annular portion is configured to engage the first connector and the second annular portion is configured to engage the second connector. When a pressure within the lumen is negative, atmospheric acting on the annular wall compresses the sealing member to define a contact force between the second annular portion and the second connector sufficient to define a fluid seal between the sealing member and the second connector.

The pressure within the lumen is defined in response to a fluid pressure within a lumen extending through the first and second connectors and the lumen may be in fluid communication with the lumen extending through the first and second connectors.

In some embodiments, when the pressure within the lumen is negative, atmospheric acting on the annular wall compresses the sealing member to define a contact force between the first annular portion and the first connector sufficient to define a fluid seal between the sealing member and the first connector.

In some embodiments, the first annular portion is attached to the first connector and may also be sealably attached to the first connector. The second annular portion is configured to slidably engage the second connector when a non-negative pressure is defined within the lumen.

In some embodiments, the second connector includes a first annular connector wall and a second annular connector wall spaced radially outward of the first annular connector wall. A lateral bottom wall extends between the first and second annular connector walls to define an annular cavity, and the second annular portion is disposed within the annular cavity.

An inside surface of the second annular portion is configured to slidably engage the first annular connector wall, and an outside surface of the second annular portion is configured to slidably and sealably engage the second annular connector wall. When a negative pressure is defined within the lumen, a fluid seal is defined between the inside surface of the second annular portion and the first annular connector wall, and when a non-negative pressure is defined within the lumen, a fluid seal is defined between the outside surface of the second annular portion and the second annular connector wall.

One of the first connector or the second connector may be attached to a component of a targeted temperature management (TTM) system, and the component may be one of a TTM module, a fluid delivery line, or thermal contact pad. The fluid pressure may be defined in accordance with operation of the targeted temperature management system.

The sealing member may include a septum extending across the lumen between the first connector and the second connector, and the septum includes a pressure actuated valve. The valve configured to prevent fluid flow through the septum when a fluid pressure across the septum is below a defined pressure limit, and allow fluid flow through the septum when the fluid pressure across the septum exceeds the defined pressure limit.

Also disclosed herein is a method of defining a seal between fluid connectors. The method includes (i) providing a tubular sealing member defining a lumen extending between a first end and a second end, (ii) inserting a first connector into the sealing member via the first end to define a first engagement, (iii) inserting a second connector into the sealing member via the second end to define a second engagement, (iv) establishing a negative pressure within the lumen to transition the sealing member from a first engagement configuration to a second engagement configuration. In the first engagement configuration, at least one of the first connector or the second connector is not sealably coupled with the sealing member, and in the second engagement configuration, atmospheric pressure compresses the sealing member to define a fluid seal between the least one of the first connector or the second connector and the sealing member. In the second engagement configuration, separation of the second connector from the first connector may be prevented.

The method may further include (i) establishing a non-negative pressure within the lumen to transition the sealing member from the second engagement configuration to the first engagement configuration and (ii) separating the second connector from the first connector.

These and other features of the concepts provided herein will become more apparent to those of skill in the art in view of the accompanying drawings and the following description, which describe particular embodiments of such concepts in greater detail.

BRIEF DESCRIPTION OF DRAWINGS

A more particular description of the present disclosure will be rendered by reference to specific embodiments thereof that are illustrated in the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope. Example embodiments of the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

FIG. **1** illustrates a side cross-sectional view of a sealing member for providing a fluid seal between connectors, in accordance with some embodiments.

FIG. **2** illustrates a side cross-sectional view of a connector system including a second embodiment of the sealing member, in accordance with some embodiments.

FIG. **3**A illustrates a side cross-sectional view of a third embodiment of the sealing member, in accordance with some embodiments.

FIG. **3**B illustrates a septum of the sealing member of FIG. **3**A, in accordance with some embodiments.

DETAILED DESCRIPTION

Before some particular embodiments are disclosed in greater detail, it should be understood that the particular embodiments disclosed herein do not limit the scope of the concepts provided herein. It should also be understood that a particular embodiment disclosed herein can have features that can be readily separated from the particular embodiment and optionally combined with or substituted for features of any of a number of other embodiments disclosed herein.

Regarding terms used herein, it should also be understood the terms are for the purpose of describing some particular embodiments, and the terms do not limit the scope of the concepts provided herein. Ordinal numbers (e.g., first, second, third, etc.) are generally used to distinguish or identify different features or steps in a group of features or steps, and do not supply a serial or numerical limitation. For example, "first," "second," and "third" features or steps need not necessarily appear in that order, and the particular embodiments including such features or steps need not necessarily be limited to the three features or steps. Labels such as "left," "right," "top," "bottom," "front," "back," and the like are used for convenience and are not intended to imply, for example, any particular fixed location, orientation, or direction. Instead, such labels are used to reflect, for example, relative location, orientation, or directions. Singular forms of "a," "an," and "the" include plural references unless the context clearly dictates otherwise. The words "including," "has," and "having," as used herein, including the claims, shall have the same meaning as the word "comprising." Furthermore, the terms "or" and "and/or" as used herein are to be interpreted as inclusive or meaning any one or any combination. As an example, "A, B or C" or "A, B and/or C" mean "any of the following: A; B; C; A and B; A and C; B and C; A, B and C." An exception to this definition will occur only when a combination of elements, components, functions, steps or acts are in some way inherently mutually exclusive.

The phrases "connected to" and "coupled to" refer to any form of interaction between two or more entities, including mechanical, electrical, magnetic, electromagnetic, fluid, signal, communicative (including wireless), and thermal interaction. Two components may be connected or coupled to each other even though they are not in direct contact with each other. For example, two components may be coupled to each other through an intermediate component.

Any methods disclosed herein include one or more steps or actions for performing the described method. The method steps and/or actions may be interchanged with one another. In other words, unless a specific order of steps or actions is required for proper operation of the embodiment, the order and/or use of specific steps and/or actions may be modified. Moreover, sub-routines or only a portion of a method described herein may be a separate method within the scope of this disclosure. Stated otherwise, some methods may include only a portion of the steps described in a more detailed method.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by those of ordinary skill in the art.

FIG. **1** illustrates a cross-sectional side view of a sealing member **100** coupled between representative fluid connectors, i.e., the first connector **116** and the second connect **117**, in a connected state. A fluid lumen **113** extends longitudi-

nally through the connectors **116**, **117**. The sealing member **100** is configured to provide a fluid seal between the first and second connectors **116**, **117**. In some embodiments, the sealing member **100** may define a primary seal between the connectors. In other embodiments, the sealing member **100** may define a secondary seal (i.e., a backup seal) between the first and second connectors **116**, **117**.

In some embodiments, the first and second connectors **116**, **117** may be attached to components of a TTM system (not shown). For example, the first and second connectors **116**, **117** may define a fluid connection between a fluid delivery line and a thermal pad. In another example, the first and second connectors **116**, **117** may define a fluid connection between a fluid delivery line and a TTM module.

The sealing member **100** may generally define a tubular shape having an annular wall **110**. The annular wall **110** may extend circumferentially around and longitudinally along each of the connectors **116**, **117**. The sealing member **100** may be positioned with respect to the connectors **116**, **117** so that a junction point **115** of the connectors **116**, **117** is located between a first end **101** and a second end **102** of the sealing member **100**.

The sealing member **100** may be an elastic sleave/shroud configured to deflect or deform in response to externally applied forces. In some embodiments, the sealing member **100** may include one or more deflectable/deformable portions. The sealing member **100** or at least a portion thereof may be formed of a flexible/deformable material such as silicone, ethylene propylene diene monomer rubber (EPDM), a natural rubber, or any other suitably flexible material. In some embodiments, the sealing member **100** may include supporting structural elements, such as a coil, longitudinal stiffening wires, circular rings, or any other structure elements consistent with the functionality of the sealing member **100**.

The sealing member **100** may be attached to the first connector **116** to inhibit or prevent longitudinal displacement of the sealing member **100** with respect to the first connector **116**. In some embodiments, rotation of the sealing member **100** with respect to the first connector **116** may also be inhibited. The attachment of the sealing member **100** to the first connector **116** may define a fluid seal **132** between sealing member **100** and the first connector **116**.

The sealing member **100** may be coupled with the first connector **116** via a contact force between the sealing member **100** and the first connector **116**. For example, a first engagement portion **131** of the sealing member **100** may be sized to fit within a recess **133** of the first connector **116** while defining an interference fit with the first connector **116**. In some embodiments, the sealing member **100** may include a separate device (e.g., a band clamp, not shown) to define the contact force. In other embodiments, the sealing member **100** may be bonded to the first connector **116** via an adhesive. The coupling of the first engagement portion **131** with the first connector **116** may define the fluid seal **132** between the sealing member **100** and the first connector **116**. By way of summary, the sealing member **100** may be permanently attached to the first connector **116** or selectively attached to and/or detached from the first connector **116**.

The sealing member **100** engages the second connector **117** via a second engagement portion **141**. The second engagement portion **141** is sized to fit within a recess **143** defining an interference fit with the second connector **117**. The interference fit is defined to accommodate longitudinal displacement of the second connector **117** relative to sealing member **100**. In other words, a contact force **144** between the second engagement portion **141** and second connector **117** may be sufficiently minimal to allow the second connector **117** to be inserted into and extracted from the sealing member **100** manually be a clinician while also defining a seal **142** between the sealing member **100** and the second connector **117**.

The sealing member **100** defines an annular chamber **105** (e.g., annular space or gap) between the connectors **116**, **117** and the annular wall **110**. The chamber **105** is bounded on the ends by the engagement portions **131**, **141**. The chamber **105** may be in fluid communication with the lumen **113** via a leak path between the connectors **116**, **117** at the junction point **115**. As such, the fluid pressure **114** within the lumen **113** may define a chamber pressure **106** of the chamber **105**. In an instance of a negative pressure within the lumen **113**, the resulting negative chamber pressure **106** causes atmospheric pressure to exert a radially inward force **130** on the annular wall **110**. In such an instance, the radially inward force **130** causes an increase in the contact force **144** between the second engagement portion **141** and the second connector **117**. The seal **142** between the second engagement portion **141** and the second connector **117** may be enhanced by the increase in the contact force **144** resulting from the negative chamber pressure **106**.

In some embodiments, the radially inward force **130** applied to the annular wall **110** may also increase a contact force **134** between the first engagement portion **131** and the first connector **10**. Consequently, the negative pressure **114** with the lumen **113** may define a greater integrity of the seal **132**.

The sealing member **100** is configured to engage the second connector **117** according to a first engagement configuration and a second engagement configuration as defined by the pressure **114** within the lumen **113**. More specifically, the sealing member **100** may be disposed in a first engagement configuration when the pressure **114** is non-negative. The sealing member **100** may transition toward the second engagement configuration in response to a negative pressure **114**. In the first engagement configuration, the sealing member **100** may facilitate coupling and decoupling of the connectors **116**, **117**. As such, longitudinal and/or rotational displacement between the sealing member **100** and the second connector **117** is allowed in the first engagement configuration.

The second engagement configuration defines enhanced engagement properties over the first engagement configuration. The second engagement configuration defines a greater integrity of the seal **142** than the first engagement configuration. Similarly, the second engagement configuration may define a greater frictional force between the sealing member **100** and the second connector **117** resisting longitudinal and rotational displacement of the second connector **117** with respect to the sealing member **100**.

In use, the sealing member **100** may automatically transition between the first engagement configuration and the second engagement configuration. In some embodiments, the sealing member **100** may transition from the second engagement configuration to the first engagement configuration to facilitate connection and/or disconnection of the connectors **116**, **117**. Similarly, the sealing member **100** may transition from the first engagement configuration to the second engagement configuration to establish the seal **142** only when the first connector **116** is coupled with the second connector **117**. Additionally, the sealing member **100** may transition from the first engagement configuration to the second engagement configuration in response to a change

the pressure **116** toward the negative and in some embodiments, the negative pressure may be defined by the TTM module.

A method of using the sealing member **100** may include the following steps or processes. The sealing member **100** is coupled with the first connector. The first connector **116** is coupled with the second connector **117** during which the second connector **117** is inserted within the sealing member **117**. A negative pressure is established within the lumen **113**. In the event of a leak between the connectors **116**, **117**, the negative causes the sealing member **100** to form a seal **142** between the sealing member **100** and the second connector **117**. In some embodiments, the vacuum also causes the sealing member **100** to form a seal **132** between the sealing member **100** and the first connector **116**. The negative is released from the lumen **113** and the second connector **117** is separated from the first connector **116** during which the second connector is withdrawn from the sealing member **100**.

FIG. **2** illustrates a connector system **250** in a connected state. The connector system **250** generally includes a first connector **216**, a complementary second connector **217**, and sealing member **200**. The sealing member **200** can, in certain respects, resemble components of the sealing member **100** described in connection with FIG. **1**. It will be appreciated that all the illustrated embodiments may have analogous features. Accordingly, like features are designated with like reference numerals, with the leading digits increment to "2." For instance, the annular wall is designated as "**110**" in FIG. **1**, and an analogous annular wall is designated as "**210**" in FIG. **2**. Relevant disclosure set forth above regarding similarly identified features thus may not be repeated hereafter. Moreover, specific features of the sealing member **100** and related components shown in FIG. **1** may not be shown or identified by a reference numeral in the drawings or specifically discussed in the written description that follows. However, such features may clearly be the same, or substantially the same, as features depicted in other embodiments and/or described with respect to such embodiments. Accordingly, the relevant descriptions of such features apply equally to the features of the sealing member **200**. Any suitable combination of the features, and variations of the same, described with respect to the sealing member **100** and components illustrated in FIG. **1** can be employed with the sealing member **200** and components of FIG. **2**, and vice versa. This pattern of disclosure applies equally to further embodiments depicted in subsequent figures and described hereafter.

The sealing member **200** is sealably attached to a first connector **216**. The second connector **217** includes an inner annular wall **271** defining the lumen of the second connect **217**. The second connector **217** further includes an outer annular wall **272** spaced radially away from the inner annular wall **271**. A bottom wall **273** extends between the inner wall **271** and the outer wall **272** to define an annular cavity **275** (i.e., a receiving moat). The cavity **275** includes an inner sealing surface **276** and an outer sealing surface **277**.

As shown in FIG. **2**, when the connectors **216**, **217** are coupled together, an extending portion **211** (i.e., an elastomeric sleeve) of the sealing member **210** is inserted within the cavity **275**. When inserted, an expanded portion **212** of the sealing member **210** is disposed adjacent the outer sealing surface **277**. The expanded portion **212** is sized to sealably contact the outer sealing surface **277**. In other words, in the free state (i.e., absent any external forces), an outside diameter defined by the expanded portion **212** is greater than an inside diameter defined by the outer sealing surface **277**. Consequently, upon coupling of the connectors **216**, **217**, the expanded portion **212** is compressed (i.e., forced radially inward) by the outer sealing surface **277** defining a seal **252** between the expanded portion **212** and the outer sealing surface **277** or more generally, between the sealing member **200** and the second connector **217**.

In similar fashion to the sealing member **100** described above, the sealing member **200** may transition between a first engagement configuration and second engagement configuration in accordance with a change of fluid pressure **214** within the lumen **213**. In the first engagement configuration, consistent with a positive/zero fluid pressure **214**, the seal **252** is established between the sealing member **200** and the second connector **217**. In the second engagement configuration, consistent with a negative fluid pressure **214**, the seal **242** is established or enhanced between the sealing member **200** and the second connector **217**.

In use, the seal **252** prevents leakage of water from the junction point **215** when a positive/zero pressure **214** is present within the lumen **213**. More specifically, a positive/zero pressure **214** translates to the positive/zero chamber pressure **206** within the chamber **205** allowing the expanded portion **212** to define a contact force **231** against the outer sealing surface **277**. The radially outward force **231** causes the expanded portion **212** to form the seal **252** with the outer sealing surface **277**.

Similarly, air leakage into the lumen **213** is prevented by the seal **242** when a negative fluid pressure **214** is present within the lumen **213**. More specifically, the negative fluid pressure **214** translates to a negative chamber pressure **206** causing the atmospheric pressure to exert a radially inward force **230** on the annular wall **210**. The radially inward force causes the engagement portion **241** to form the seal **242** with the inner sealing surface **276**.

A method of using the sealing member **200** may include forming the seal **252** between the sealing member **200** and the second connector **217** upon coupling of the second connector **217** with the first connector **216**.

FIG. **3**A illustrates a sealing member **300** in use with a first connector **316** and second connector **317**. The sealing member **300** may generally define a tubular shape defining a sealing member lumen **303**. The sealing member **300** includes an annular wall **310** and a septum wall **311** extending across the sealing member lumen **303**. The annular wall **310** may extend circumferentially around and longitudinally along each of the connectors **316**, **317**. The sealing member **300** may be positioned with respect to the connectors **316**, **317** so that the ends **316**A, **317**A of the connector **316**, **317** are disposed adjacent the septum wall **311**.

The sealing member **300** engages the second connector **317** via a second engagement portion **341**. The second engagement portion **341** is sized to define a sliding fit between the sealing member **300** and the second connector **317**. In other words, a contact force **344** between the second engagement portion **341** and second connector **317** may be sufficiently minimal to allow the second connector **317** to be inserted into and extracted from the sealing member **300**.

The sealing member **300** defines an annular chamber **307** (e.g., annular space or gap) between the first connector **316** and the annular wall **310**. The chamber **307** is bounded on the ends by the septum wall **311** and the first engagement portion **331**. The chamber **307** may be in fluid communication with the lumen **313**A via a leak path between the first connector **316** and the septum wall **311**. As such, the fluid pressure **314**A within the lumen **313**A may define a chamber pressure **308** of the chamber **307**. In an instance of a negative

fluid pressure **314**A within the lumen **313**A, the resulting negative chamber pressure **308** causes atmospheric pressure to exert a radially inward force **330**A on the annular wall **310**. In such an instance, the radially inward force **330**A causes an increase in the contact force **334** between the first engagement portion **331** and the first connector **316**. A seal **332** between the first engagement portion **331** and the first connector **316** may be defined by the contact force **334** resulting from the negative chamber pressure **308**.

Similarly, the sealing member **300** defines an annular chamber **305** (e.g., annular space or gap) between the second connector **317** and the annular wall **310**. The chamber **305** is bounded on the ends by the septum wall **311** and the second engagement portion **341**. The chamber **305** may be in fluid communication with the lumen **313**B via a leak path between the second connector **317** and the septum wall **311**. As such, the fluid pressure **314**B within the lumen **313**B may define a chamber pressure **306** of the chamber **305**. In an instance of a negative fluid pressure **314**B within the lumen **313**B, the resulting negative chamber pressure **306** causes atmospheric pressure to exert a radially inward force **330**B on the annular wall **310**. In such an instance, the radially inward force **330**B causes an increase in the contact force **344** between the second engagement portion **341** and the second connector **317**. A seal **342** between the second engagement portion **341** and the second connector **317** may be defined by the contact force **344** resulting from the negative chamber pressure **306**.

The sealing member **300** may be attached to the first connector **316** to inhibit or prevent longitudinal displacement of the sealing member **300** with respect to the first connector **316**. In some embodiments, rotation of the sealing member **300** with respect to the first connector **316** may also be inhibited. The attachment of the sealing member **300** to the first connector **316** may define a fluid seal between sealing member **300** and the first connector **316**. In other embodiments, the sealing member **300** may include a separate device (e.g., a band clamp, not shown) to define the contact force. In other embodiments, the sealing member **300** may be bonded to the first connector **316** via an adhesive. The sealing member **300** may be permanently attached to the first connector **316** or selectively attached to and/or detached from the first connector **316**.

The sealing member **300** is configured to engage the second connector **317** according to a first engagement configuration and a second engagement configuration as defined by a pressure within the lumen **313**B. More specifically, the sealing member **300** may be disposed in a first engagement configuration when the pressure **314**B is non-negative. The sealing member **300** may transition toward the second engagement configuration in response to a pressure **314**B that is negative. In the first engagement configuration, the sealing member **300** may facilitate coupling and decoupling of the connectors **316**, **317**. As such, longitudinal and/or rotational displacement between the sealing member **300** and the second connector **317** is allowed in the first engagement configuration.

The second engagement configuration may define enhanced engagement properties over the first engagement configuration. In some embodiments, the second engagement configuration may define a greater integrity of the seal **342** than the first engagement configuration. Similarly, the second engagement configuration may define a greater frictional force between the sealing member **300** and the second connector **317** resisting longitudinal and rotational displacement of the second connector **317** with respect to the sealing member **300**.

In some embodiments, the septum wall **311** defines a face seal **335** with the end **316**A of the first connector **316**. The septum wall **311** may also define a face seal **345** with the end **317**A of the second connector **317**. As such the septum wall **311** may define a fluid seal between the connectors **316**, **317**.

FIG. **3**B is an end view of the sealing member **300**. The septum wall **311** includes one or more slits **351** extending through the septum wall **311**. The slits **351** along with the corresponding elastomeric flaps **352** define a pressure actuated star valve **350**. The slits **351** and flaps **352** are configured to define a septum seal in the absence of a pressure difference across the septum **311**. More specifically, when the pressure difference across the septum **311** is below a defined limit, the star valve **350** is in a closed state preventing fluid flow through the sealing member **300**. Conversely, when the pressure difference across the septum **311** exceeds the defined limit, the flaps **352** deflect to transition the star valve **350** to an open state allowing fluid flow through the sealing member **300**.

In use, deliberate fluid flow (e.g., flow caused by a pump) through the connectors **316**, **317** produces a pressure difference across the septum **311** causing the star valve **350** to open. When the fluid flow is stopped, the pressure difference is eliminated allowing the star valve **350** to close. In further use, the sealing member **300** may be attached to the first connector **316** so that when deliberate fluid flow is stopped and the connectors **316**, **317** are separated, the sealing member **300** remains coupled with the first connector **316** preventing inadvertent fluid flow out of the first connector **316**.

Without further elaboration, it is believed that one skilled in the art can use the preceding description to utilize the invention to its fullest extent. The claims and embodiments disclosed herein are to be construed as merely illustrative and exemplary, and not a limitation of the scope of the present disclosure in any way. It will be apparent to those having ordinary skill in the art, with the aid of the present disclosure, that changes may be made to the details of the above-described embodiments without departing from the underlying principles of the disclosure herein. In other words, various modifications and improvements of the embodiments specifically disclosed in the description above are within the scope of the appended claims. Moreover, the order of the steps or actions of the methods disclosed herein may be changed by those skilled in the art without departing from the scope of the present disclosure. In other words, unless a specific order of steps or actions is required for proper operation of the embodiment, the order or use of specific steps or actions may be modified. The scope of the invention is therefore defined by the following claims and their equivalents.

What is claimed is:

1. A sealing member for providing a seal between fluid connectors, comprising:

a tubular member defining a lumen extending between a first end and a second end, the tubular member configured to receive a first connector via the first end and a second connector via the second end, the tubular member comprising an annular wall defining:

a first annular portion adjacent the first end, the first annular portion configured to engage the first connector;

a second annular portion adjacent the second end, the second annular portion configured to engage the second connector; and

an annular chamber extending between the first annular portion and the second annular portion, the annular

chamber configured to receive the first connector and the second connector therein;

wherein during use:

the first connector and the second connector extend into the annular chamber such that the annular chamber defines an annular space between the annular wall and each of the first connector and the second connector,

the annular chamber adjacent the first annular portion is in fluid communication with the annular chamber adjacent the second annular portion, and

when a pressure within the lumen is negative, atmospheric pressure acting on the annular wall compresses the tubular member to define at least a contact force between the second annular portion and the second connector sufficient to define a fluid seal between the tubular member and the second connector.

2. The sealing member of claim **1**, wherein the pressure within the lumen is defined in response to a fluid pressure within a fluid lumen extending through the first connector and the second connector.

3. The sealing member of claim **2**, wherein the lumen is in fluid communication with the fluid lumen.

4. The sealing member of claim **1**, wherein when the pressure within the lumen is negative, the atmospheric pressure acting on the annular wall compresses the tubular member to define the contact force between the first annular portion and the first connector sufficient to define the fluid seal between the tubular member and the first connector.

5. The sealing member of claim **1**, wherein the first annular portion is configured to attach to the first connector.

6. The sealing member of claim **1**, wherein the first annular portion is configured to sealably attach to the first connector.

7. The sealing member of claim **1**, wherein the second annular portion is configured to slidably engage the second connector when a non-negative pressure is defined within the lumen.

8. The sealing member of claim **1**, further comprising a septum extending across the lumen between the first annular portion and the second annular portion, the septum including a pressure actuated valve configured to:

prevent fluid flow through the septum when a fluid pressure across the septum is below a defined pressure limit, and

allow fluid flow through the septum when the fluid pressure across the septum exceeds the defined pressure limit.

9. A fluid connector system, comprising:

a first connector;

a complementary second connector fluidly coupled with the first connector; and

a tubular sealing member defining a lumen extending between a first end and a second end, the tubular sealing member configured to receive the first connector via the first end and a second connector via the second end, the tubular sealing member, comprising an annular wall defining:

a first annular portion adjacent the first end, the first annular portion configured to engage the first connector;

a second annular portion adjacent the second end, the second annular portion configured to engage the second connector; and

an annular chamber extending between the first annular portion and the second annular portion, the annular chamber configured to receive the first connector and the second connector therein;

wherein during use:

the first connector and the second connector extend into the annular chamber such that the annular chamber defines an annular space between the annular wall and each of the first connector and the second connector,

the annular chamber adjacent the first annular portion is in fluid communication with the annular chamber adjacent the second annular portion, and

when a pressure within the lumen is negative, atmospheric pressure acting on the annular wall compresses the tubular sealing member to define at least a contact force between the second annular portion and the second connector sufficient to define a fluid seal between the tubular sealing member and the second connector.

10. The fluid connector system of claim **9**, wherein the pressure within the lumen is defined in response to a fluid pressure within a fluid lumen extending through the first connector and the second connector.

11. The fluid connector system of claim **10**, wherein the lumen is in fluid communication with the fluid lumen.

12. The fluid connector system of claim **9**, wherein when the pressure within the lumen is negative, the atmospheric pressure acting on the annular wall compresses the tubular sealing member to define a contact force between the first annular portion and the first connector sufficient to define a fluid seal between the tubular sealing member and the first connector.

13. The fluid connector system of claim **9**, wherein the first annular portion is attached to the first connector.

14. The fluid connector system of claim **9**, wherein the first annular portion is sealably attached to the first connector.

15. The fluid connector system of claim **9**, wherein the second annular portion is configured to slidably engage the second connector when a non-negative pressure is defined within the lumen.

16. The fluid connector system of claim **9**, wherein the second connector comprises:

a first annular connector wall;

a second annular connector wall spaced radially outward of the first annular connector wall; and

a lateral bottom wall extending between the first annular connector wall and the second annular connector wall, wherein the first annular connector wall, the second annular connector wall, and the lateral bottom wall define an annular cavity, and

the second annular portion is disposed within the annular cavity.

17. The fluid connector system of claim **16**, wherein:

an inside surface of the second annular portion is configured to slidably engage the first annular connector wall, and

an outside surface of the second annular portion is configured to slidably and sealably engage the second annular connector wall.

18. The fluid connector system of claim **16**, wherein:

when a negative pressure is defined within the lumen, a fluid seal is defined between an inside surface of the second annular portion and the first annular connector wall, and

when a non-negative pressure is defined within the lumen, a fluid seal is defined between an outside surface of the second annular portion and the second annular connector wall.

19. The fluid connector system of claim **9**, wherein:

one of the first connector or the second connector is attached to a component of a targeted temperature management (TTM) system, and

the component is one of a TTM module, a fluid delivery line, or a thermal contact pad.

20. The fluid connector system of claim **19**, wherein a fluid pressure is defined in accordance with operation of the targeted temperature management system.

21. The fluid connector system of claim **9**, wherein the tubular sealing member includes a septum extending across the lumen between the first connector and the second connector, the septum including a pressure actuated valve configured to:

prevent fluid flow through the septum when a fluid pressure across the septum is below a defined pressure limit, and

allow fluid flow through the septum when the fluid pressure across the septum exceeds the defined pressure limit.

22. A method of defining a seal between fluid connectors, comprising:

providing a tubular sealing member defining a lumen extending between a first end and a second end;

inserting a first connector into the tubular sealing member via the first end to define a first engagement;

inserting a second connector into the tubular sealing member via the second end to define a second engagement;

establishing a negative pressure within the lumen to transition the tubular sealing member from a first engagement configuration to a second engagement configuration, wherein:

in the first engagement configuration, at least one of the first connector or the second connector is not sealably coupled with the tubular sealing member, and

in the second engagement configuration, atmospheric pressure compresses the tubular sealing member to define a fluid seal between the at least one of the first connector or the second connector and the tubular sealing member.

23. The method of claim **22**, wherein in the second engagement configuration, separation of the second connector from the first connector is prevented.

24. The method of claim **22**, further comprising:

establishing a non-negative pressure within the lumen to transition the tubular sealing member from the second engagement configuration to the first engagement configuration; and

separating the second connector from the first connector.

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